Project presentation MaLiSu

(Nano**ma**terials for future generation **Li**thium **Su**lphur batteries)

13.09.2012, Dr. H. Althues

Fraunhofer IWS Dresden

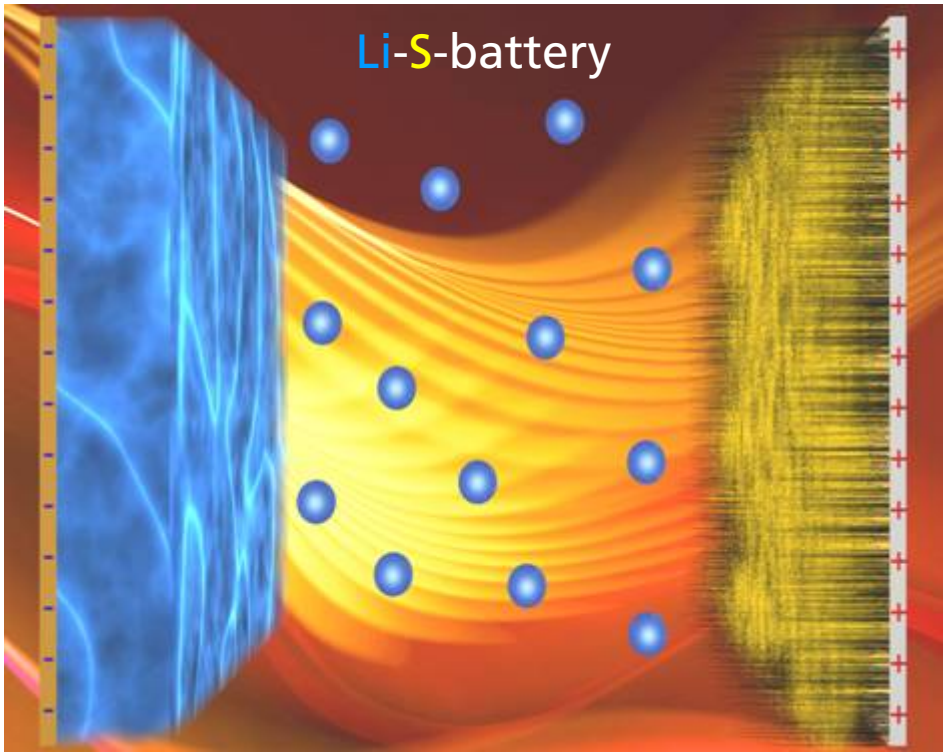
TECHNISCHE UNIVERSITÄT DRESDEN

UPPSALA UNIVERSITET

SGL GROUP THE CARBON COMPANY

VARTA micro innovation

SCANIA



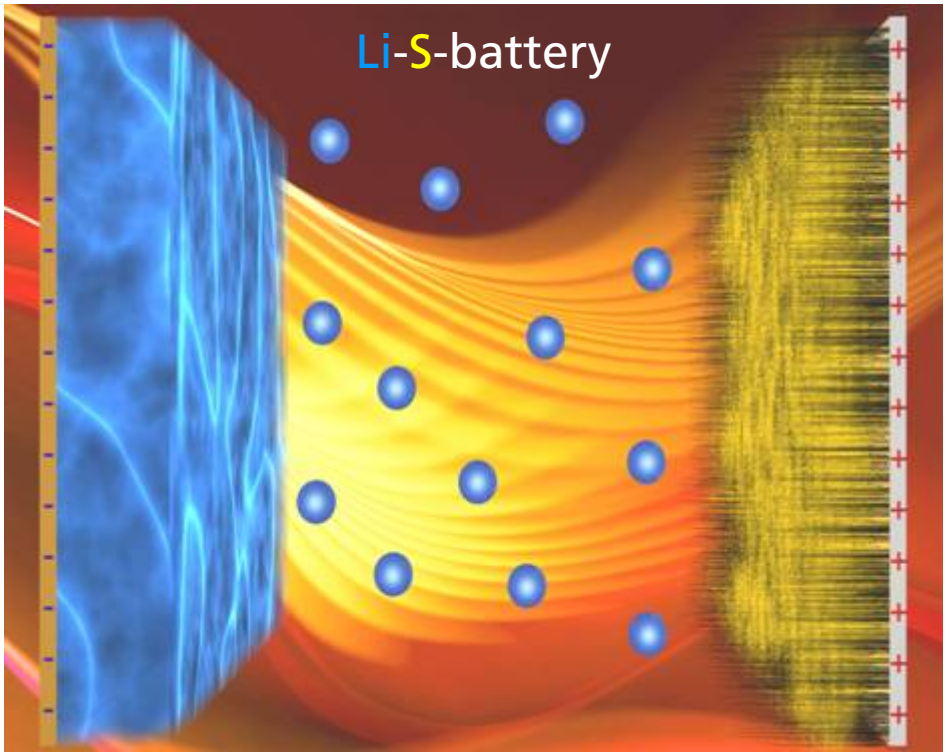
Electromobility +

Fraunhofer IWS Dresden

Project presentation MaLiSu

Overview

- Placement in the electromobility+ program
- Challenges in next generation battery development
- MaLiSu project
  - Main objectives
  - Workplan
  - Partners and their role
- Summary



Placement in the electromobility+ program

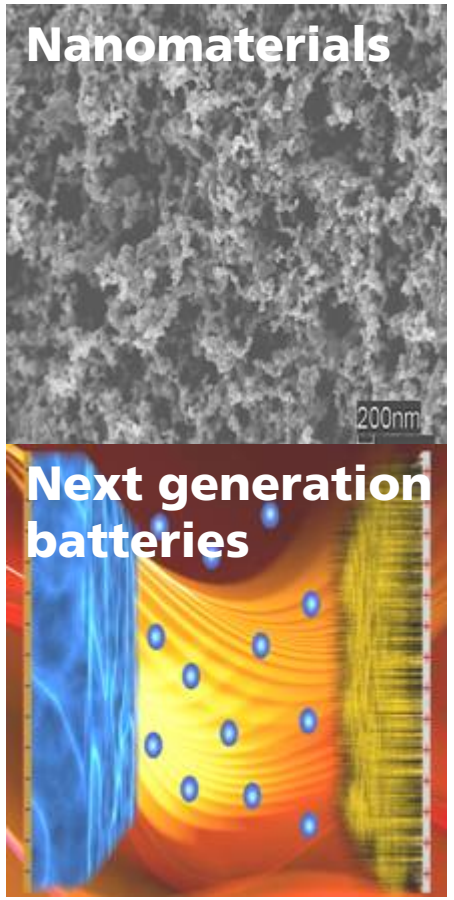
Key dimension addressed:

Technology based Innovation

- Energy storage and management
- Explorative works on future generation batteries. Role of nano-materials.

Importance of Explorative works on future generation batteries

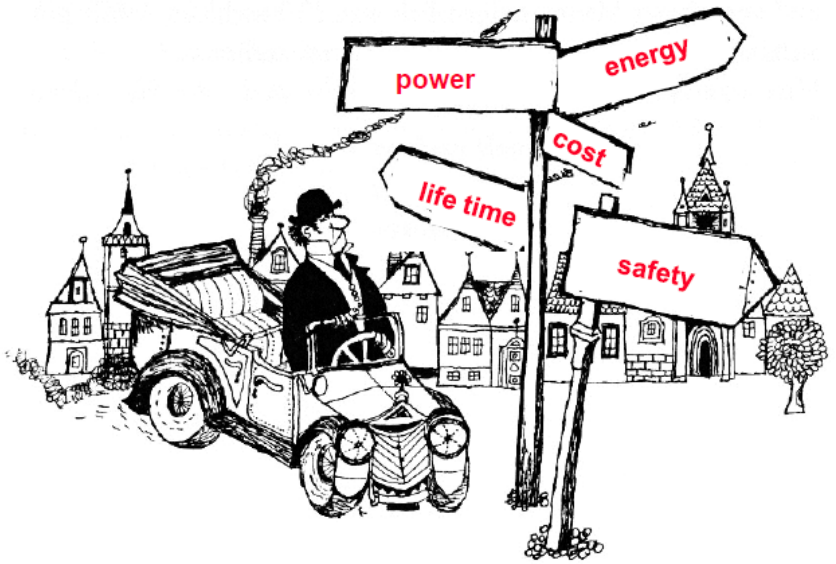
- Battery performance and costs are bottlenecks for electromobility
- Opportunity to close the knowledge gap to asian competitors for future generation batteries



Challenges in next generation battery development

Requirements on next generation batteries for electromobility

- Enhancement of
  - **Energy**-, power density
  - Safety
  - Life time
  - Costs

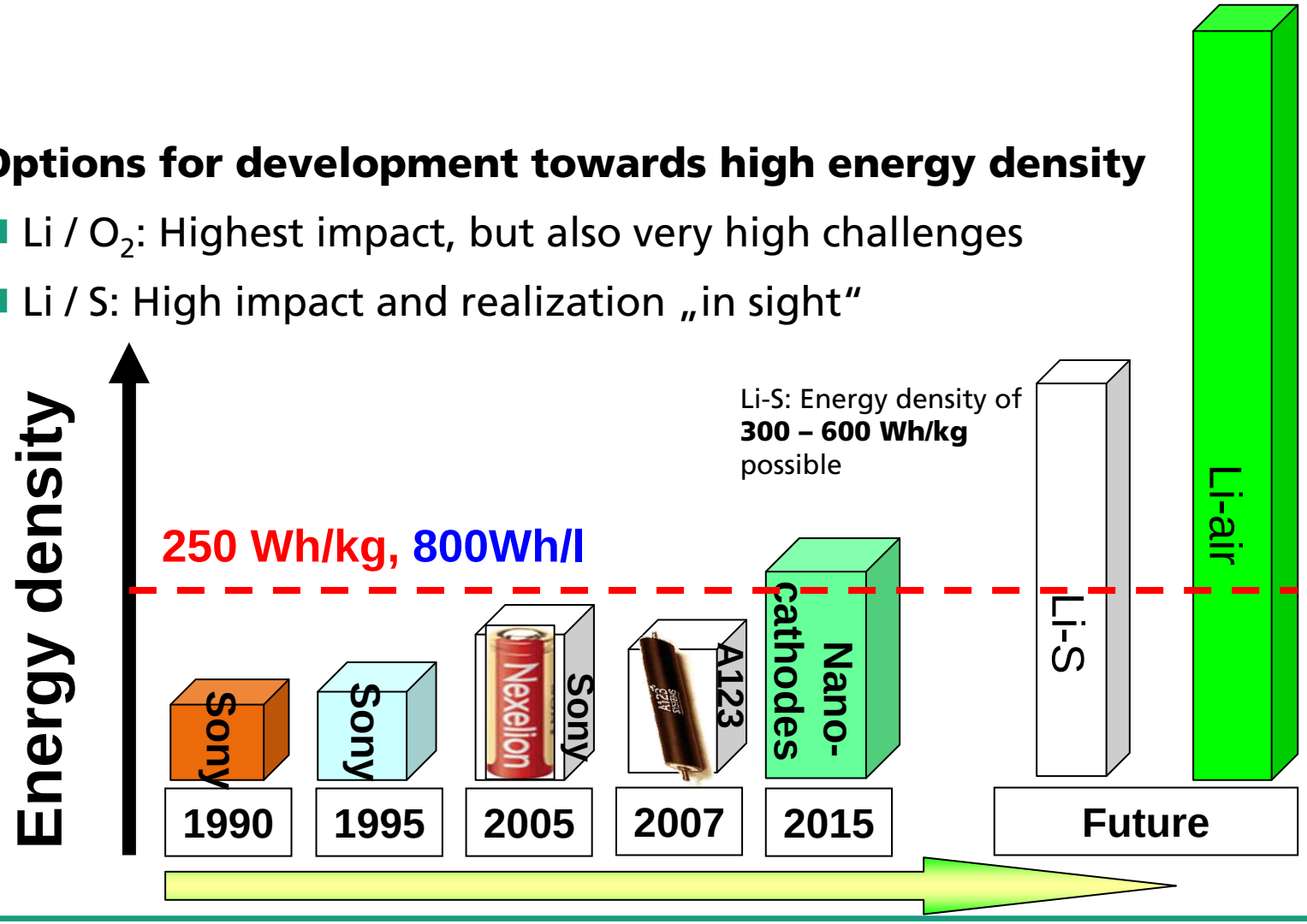


- **Energy** density limits the autonomic driving distance and is the bottleneck to broad replacement of combustion engines

Challenges in next generation battery development

Options for development towards high energy density

- Li / O_2: Highest impact, but also very high challenges
- Li / S: High impact and realization „in sight“

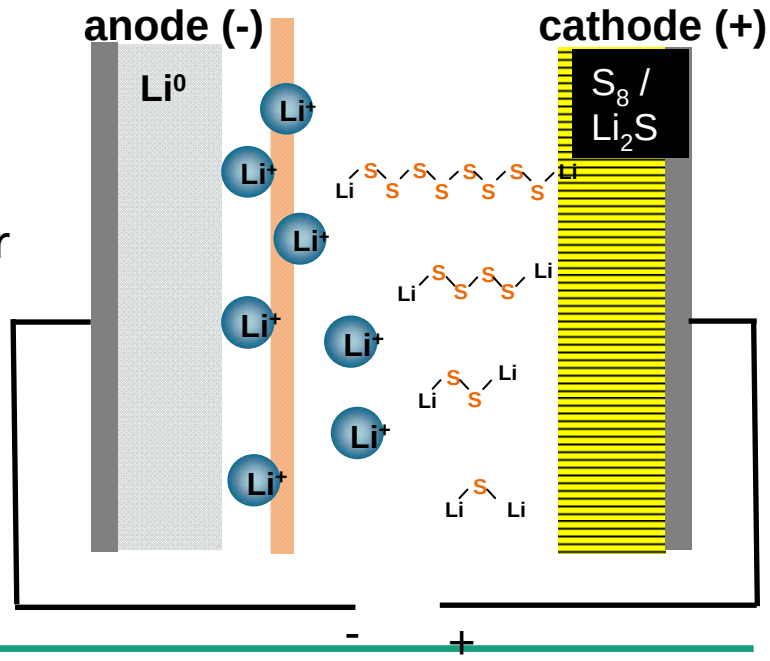


Challenges in next generation battery development

Properties of Li-Sulfur chemistry

- High potential for high specific energies (> 400 Wh/kg)
- Large challenges in material development to overcome:
  - Low conductivity / utilization of sulfur
  - Shuttle mechanism of soluble polysulfide intermediates
  - Anode (Li-metal) instability

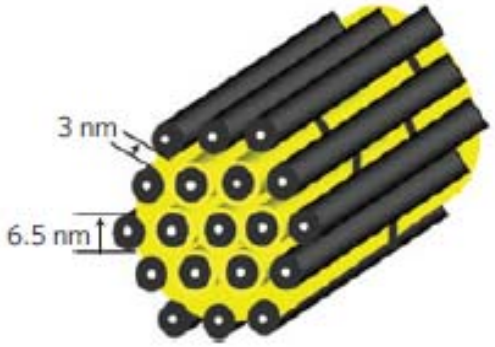
Scheme of Li-S - cell



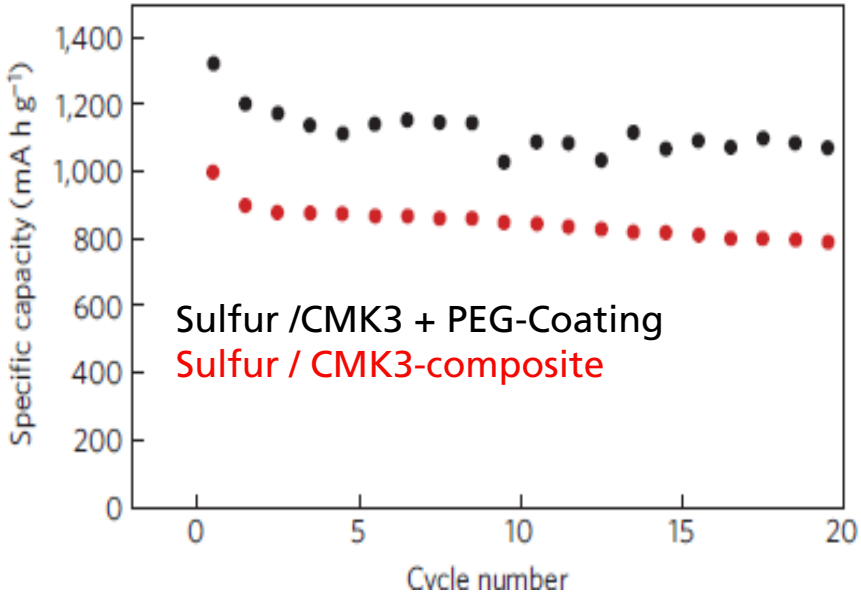
Challenges in next generation battery development

Recent developments in material research for Li-S-batteries

- Nanostructured carbons may contact and stabilize S-species
- Polymer electrolytes may act as barrier for polysulfide dissolution

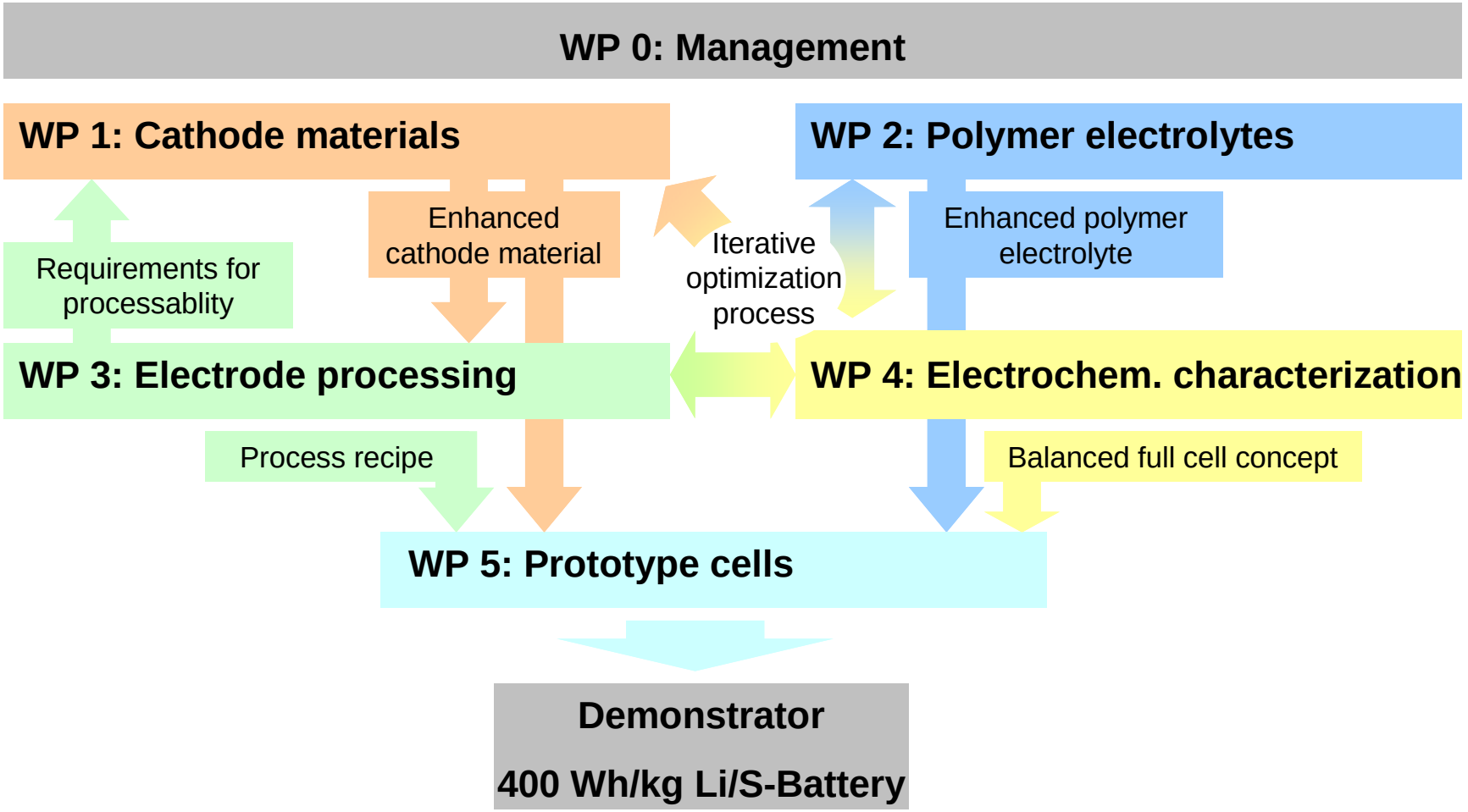


CMK-3 / sulfur / PEG nanocomposite for S-cathodes



NATURE MATERIALS | VOL 8 | JUNE 2009 | www.nature.com/naturematerials

MaLiSu project – Objectives and Workplan



Pore design for cathode materials

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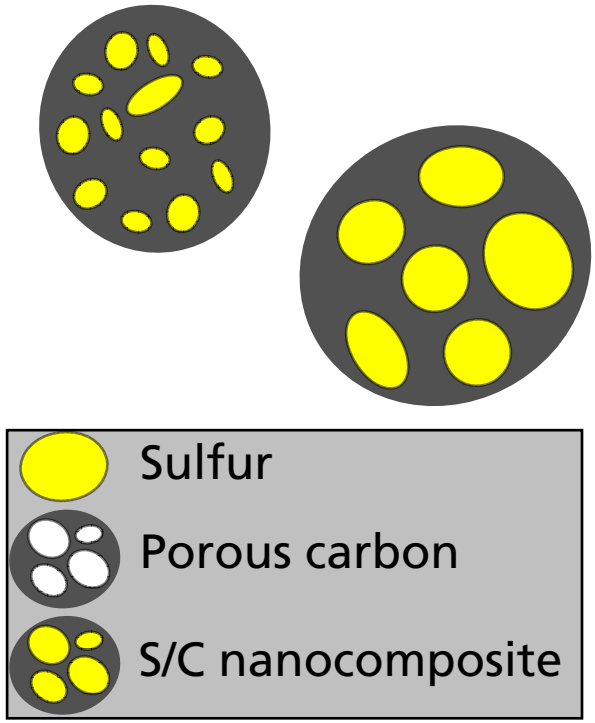
Role of partner TU Dresden

- Synthesis of nanostructured carbons with specific pore design to match the requirements for cathodes
  - micropous carbons (1-2 nm)
  - mesoporous carbons (2-50 nm)
  - hierarchical structured porous carbons

→ maximizing sulfur utilization

→ enhancing polysulfide retention



Industrially processed carbons for cathodes

SGL GROUP
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Role of partner SGL

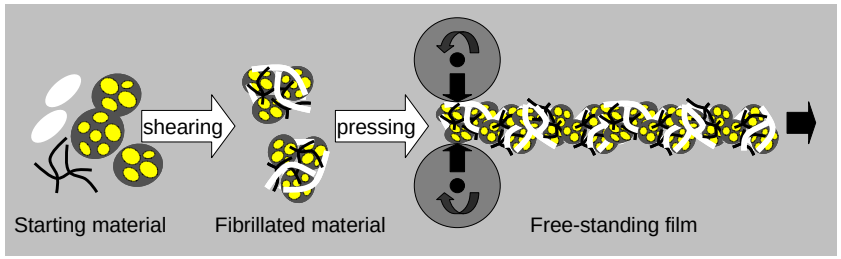
- Large scale synthesis of nanostructured carbons
  - Tailoring of pore size distribution and variation of surface area
  - Selection of scalable processes and processing of porous material in gram-scale up to kg-scale
  - Evaluation of industrial feasibility and cost potential for different processes

Solvent-free electrode processing

Fraunhofer IWS

Role of partner Fraunhofer IWS

- S/C Nanocomposite preparation
- Development of cost-efficient electrode processing
  - solvent-free processes
  - stable, high capacity cathodes
- Characterization
  - Cathode performance in battery test cells



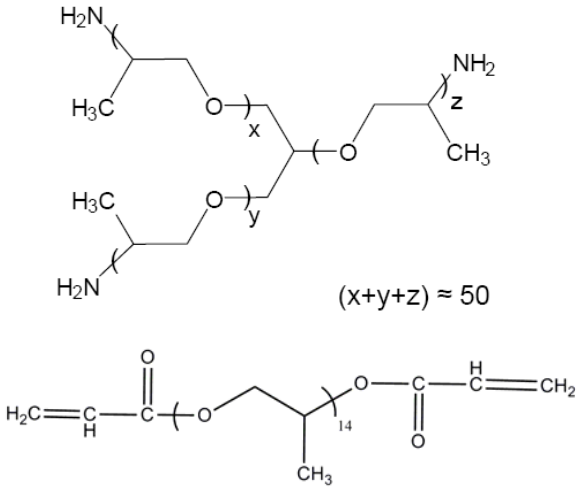
Freestanding, flexible electrode with 5 % binder

Polymer electrolytes

Role of partner Uppsala University

- Development of polymer electrolytes
  - Polymer electrolyte formulation
  - Composite (gel) electrolyte formulation
  - Polymer electrolyte characterization

Example for polymer electrolyte formulations:



+ LiTFSI salt

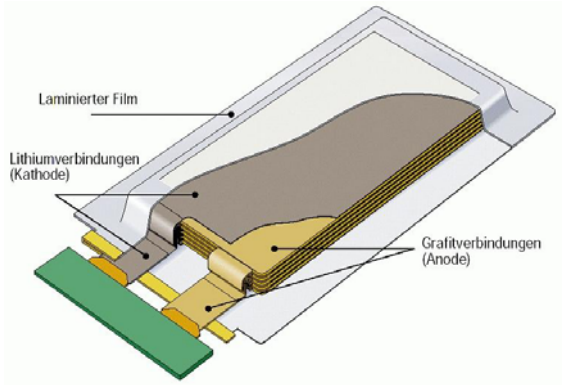
S. Tan, S. Walus, J. Hilborn, T. Gustafsson, D. Brandell, *Electrochem. Commun.*, 12 (2010) 1498.

Cell manufacturing

VARTA micro innovation

Role of partner Varta Micro Innovation

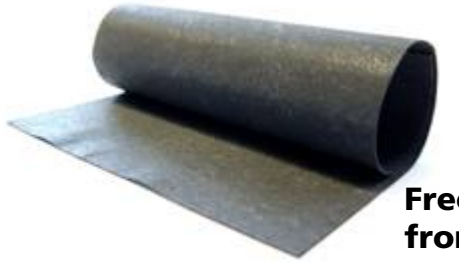
- Cell manufacturing / prototyping
  - Electrode fabrication on prototype level
  - Fabrication of demonstrator cells
  - Evaluation of demonstrator cells



First results

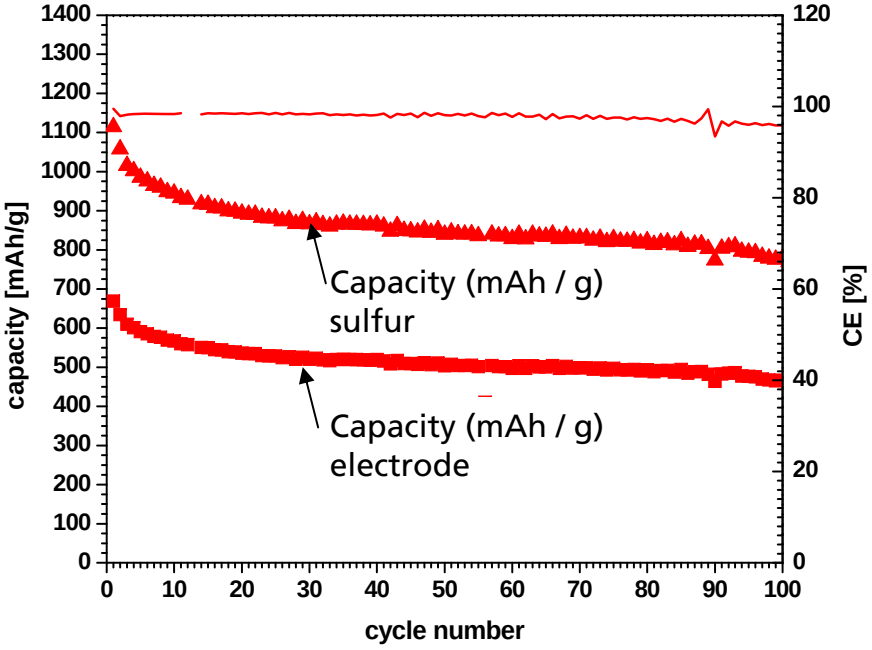
Performance of first MaLiSu cathodes:

- high sulfur utilization / specific capacity
  - 4 x higher than Li-Ion intercalation cathodes
- stable cycling (> 100 cycles)
- high coulomb efficiency



Freestanding electrode from porous carbon / sulfur nanocomposite

Cycling tests:



Summary

MaLiSu project

- Main project objectives are material, process and cell development for next generation (high energy) batteries
- Consortium involves basic and applied research institutions as well as industrial partners to ensure a fast transfer of results to exploitation
- Partners are open to cross-cutting cooperation and inter-project exchange within the electromobility+ program

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DLR Projektträger